Weight load survey room 1H18 @ Headquarters

area of corridor = 10×20 = 200 ft^2

area $\frac{41 + 26}{2} \times 60$ = 2010 ft^2

live load allowable = 200×100 psf = 20,000

2010×80 psf = 160,800

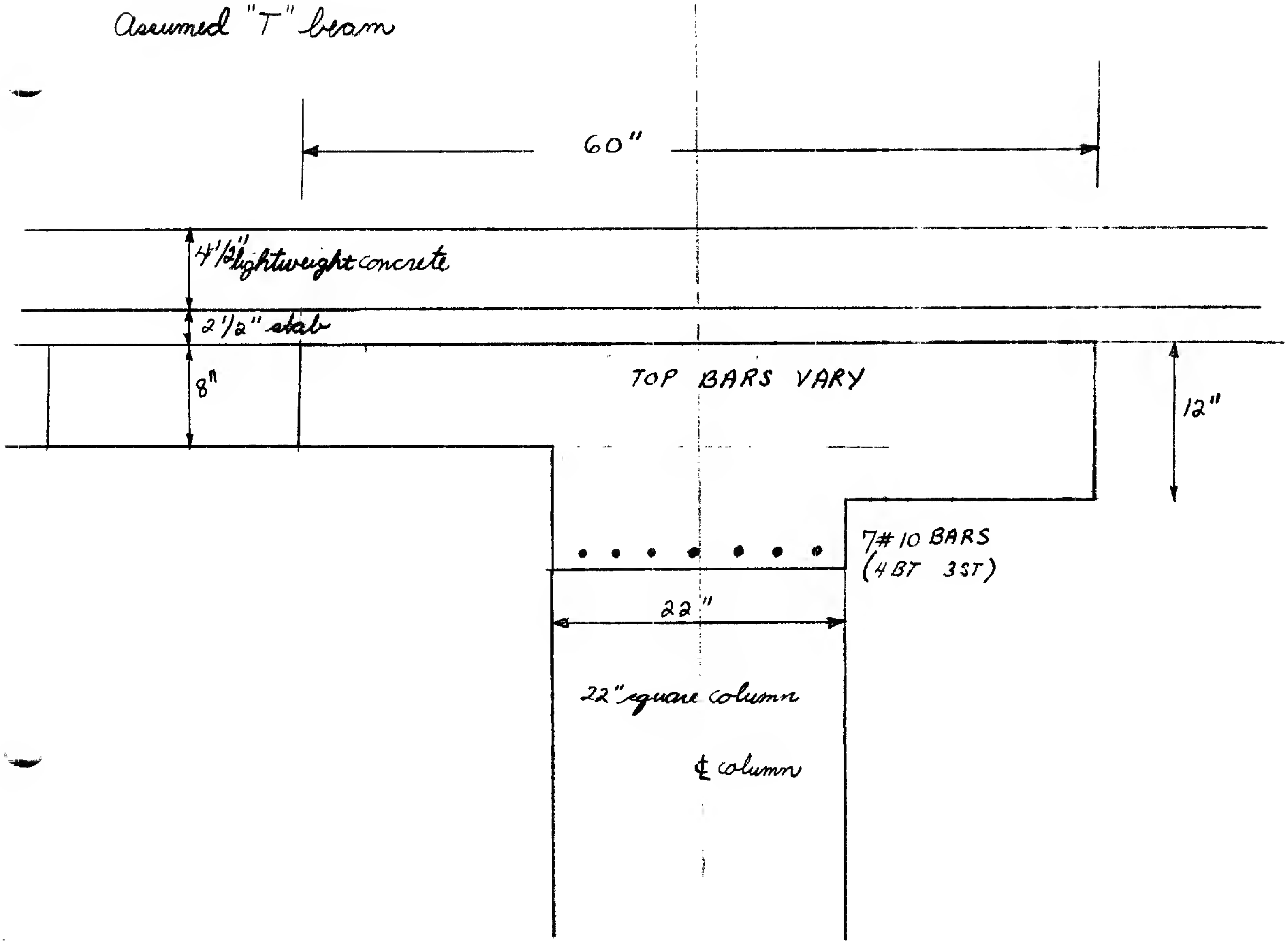
180,800

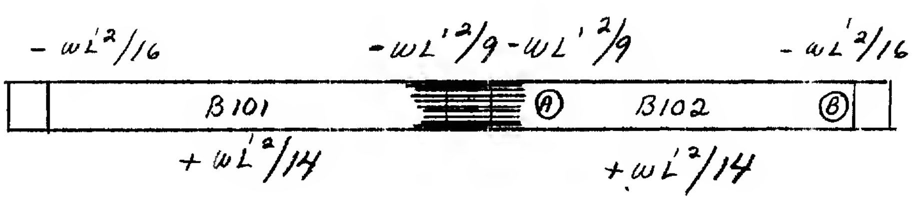
7 power files = 7×8000 56,000

124,800

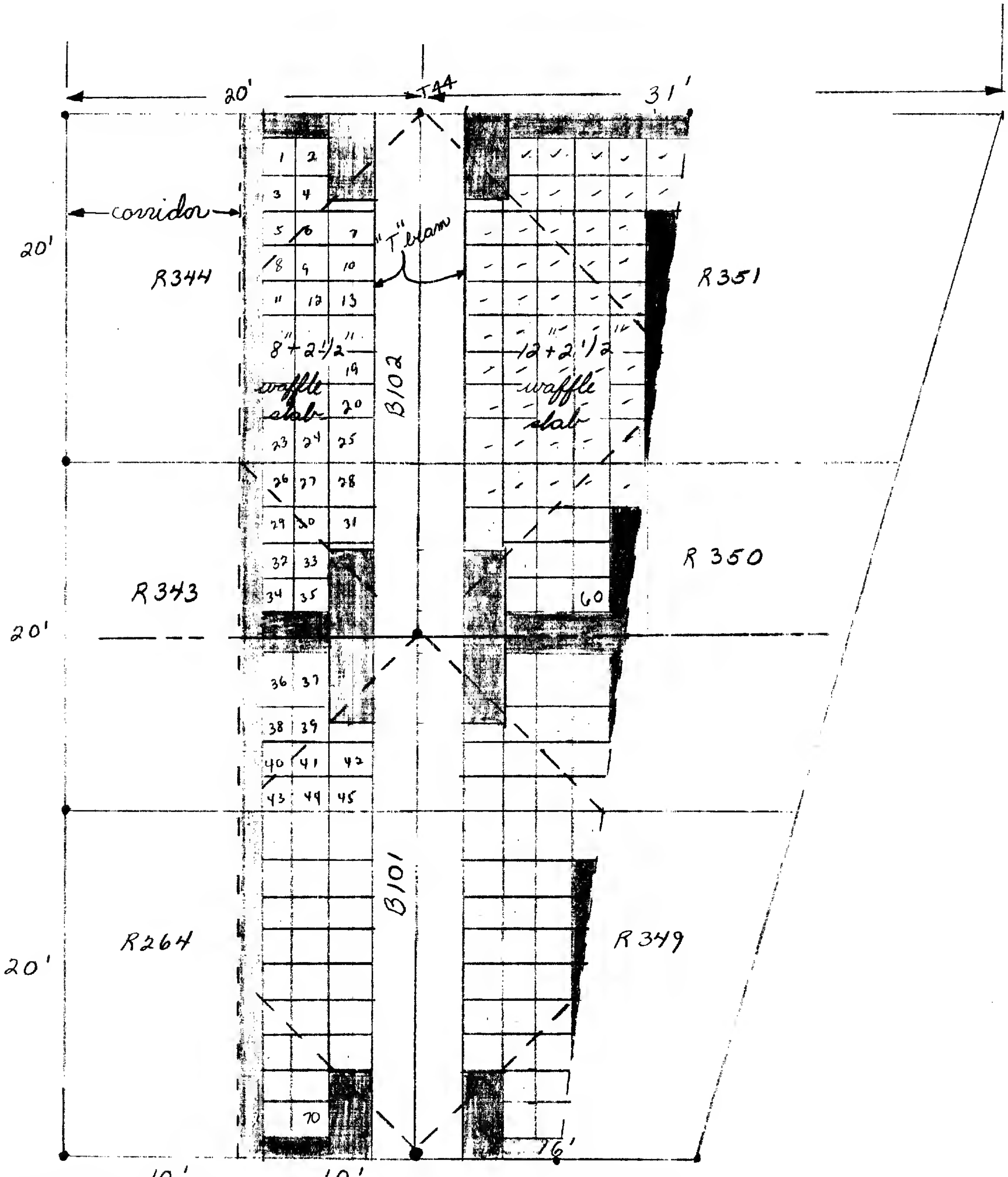
net live load remaining = $\frac{124,800}{2010 + 200}$ = 56.5 psf

Assumed "T" beam





R344	8 + 2 1/2	R351	12 + 2 1/2
R343	8 + 2 1/2	R350	12 + 2 1/2
R264	8 + 2 1/2	R349	12 + 2 1/2



files are $102'' \times 59\,3/4''$ $\quad 8.5' \times 4.98'$

$$8000\#/8.5 = 941.2\#/ft = .941\,K/ft$$

slab weight use 144 #/ft³ for regular concrete
use 100 #/ft³ for light weight concrete

$$\text{total area} = 10 \times 60 + \frac{15.5+8}{2} \times 60 = 1305\,ft^2$$

$$\text{weight of slab} = \frac{2.5}{12} \times 1305 \times 144 = 39150\#$$

$$\text{weight of lightweight concrete} = \frac{4.5}{12} \times 1305 \times 100 = 48938\#$$

$$\text{weight of beam} = \frac{(60\times8)+(9.5\times22)+4(19)}{144} \times 60 \times 144 = 45900\#$$

weight of slabs $8''+2\,1/2''$ — 70 panels $\qquad 12''+2\,1/2''$ — 101 panels

$$\text{area of } 8''+2\,1/2'' = 10 \times 60 = 600\,ft^2$$

$$\text{area of } 12+2\,1/2'' = \frac{15.5+8}{2} \times 60 = 705\,ft^2$$

$$\text{less area of beam} = 5 \times 60 = 300$$

$$\text{area (net) of } 8+2\,1/2 = 600 - 150 = 450\,ft^2$$

$$\text{area (net) of } 12+2\,1/2 = 705 - 150 = 555\,ft^2$$

$$[450 \times 8/12 - 70(1.41)](144) = 28987\#$$

$$[555 \times 1 - 101(2.14)](144) = 48796\#$$

$$\text{area around drop panels} = (10 \times 10 \times 2/12)144 \times 2\text{ panels} = 4800\#$$

partitions + ceiling below etc. = 20 psf = 20 × 1305 = 26100#

partitions etc	26100
slab	39150
lightweight concrete	48938
beam	45900
remainder of slab (8")	28987
" " " (12")	48796
drop panels	4800
Σ =	242,671

B102 is more heavily loaded

total area = 1305 ft^2

area taken by B102 = $10 \times 30 + \frac{15.5+12}{2} \times 30 = 712.5$

load on B102 = $\frac{712.5}{1305} \times 242671 = 132,493^{\#}$

wght/ft = $132.49/30 = 4.42$ K/ft

loads due to files = $8000 \times 3/30 = .8$ K/ft

assume $f'_c = 3000$ psi

cover = 1.27" (dia of #10 bar) for #10 bars   .875" for #7 bars

$f_c = 1350$ psi $f_s = 20000$ psi

shear = 60 psi

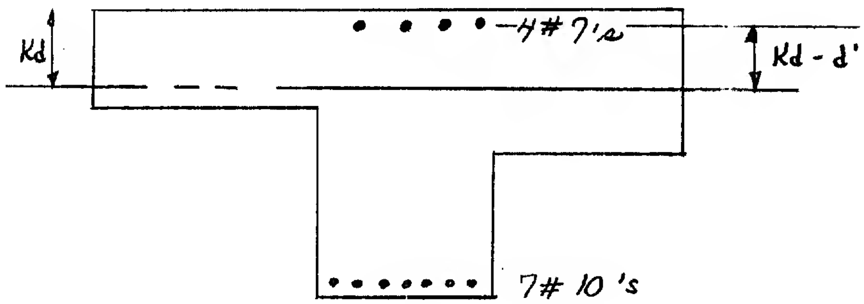
effective flange $\frac{30 \times 12}{4} = 90"$

or

$(8 \times 2.5 \times 2) + 22 = 62"$ use 60"

check midspan moment = $wL'^2/14 = (4.42+.8)(30 - 22/12)^2/14 = 296$ K-ft

beam at midspan



find N.A Σ areas about NA

$$bKd\frac{Kd}{2} + 2nA's(Kd-d') = nA_s(d-Kd)$$

$d' = .875 + .875/2 = 1.31''$ $A's = 4(.60) = 2.4\ in^2$

$d = 20 - (1.27 + \frac{1.27}{2}) = 18.1''$ $A_s = 7(1.27) = 8.89\ in^2$

$$60\frac{Kd^2}{2} + 2(10)(2.4)(Kd-1.31) = 10(8.89)(18.1-Kd)$$

$$30Kd^2 + 48Kd - 62.88 = -88.9Kd + 1609.1$$

$$30Kd^2 + 136.9Kd - 1671.98 = 0$$

$$Kd^2 + 4.56Kd - 55.73 = 0$$

$$Kd = \frac{-4.56 \pm\sqrt{4.56^2 - 4(1)(-55.73)}}{2(1)} = 5.53''$$

$$I = \frac{bKd^3}{3} + 2nA's(Kd-d')^2 + nA_s(d-Kd)^2$$

$$= \frac{60(5.53)^3}{3} + 2(10)(2.4)(5.53-1.31)^2 + 10(8.89)(18.1-5.53)^2 = 18283.7\ in^4$$

$$3382.2 + 854.8 + 14046.6 = 18283.7$$

$6 = \frac{Mc}{I} \qquad M = \frac{6I}{c}$

$M_c = \frac{1350(18283.7)}{5.53} \times \frac{1}{12000} = 372$ ft-Kips

$M_s = \frac{\frac{6}{n} I}{d - Kd} = \frac{\frac{20000}{10} \times 18283.7}{18.1 - 5.53} \times \frac{1}{12000} = 242.4$ ft-Kips

steel controls ✓

analyze B101

load = 242,671 − 132,493 = 110,178/30 = 3673#/ft = 3.67K/ft

$M = \frac{wL'^2}{14} = (3.67 + .8)(30 - {}^{22}/_{12})^2 / 14 = 253.3$ ft-Kips

if we assume B102 can carry superimposed loads + 80psf

load/ft due to 80psf = $\frac{80 \times 712.5}{30} = 1900$ #/ft = 1.9 K-ft

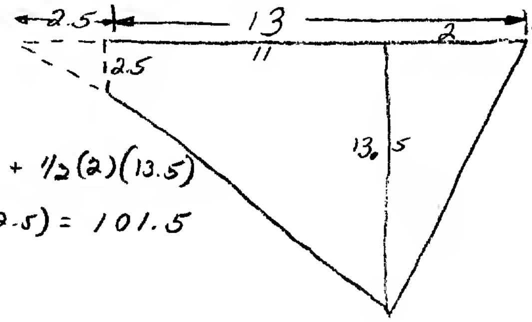
$M = \frac{wL'^2}{x}$ max M = 242.4

$$242.4 = \frac{4.42 + 1.9\left(30 - \frac{22}{12}\right)^2}{x}$$

$x = \frac{5014}{242.4} = 20.7$?

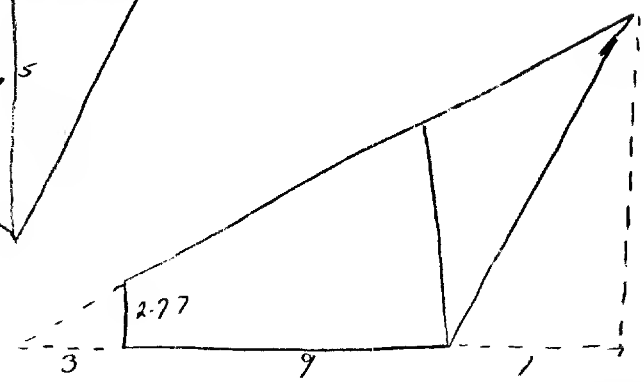
$M = \frac{wL'^2}{21}$ ← this cannot be

try reducing load based on 45° distribution



$\frac{13.5}{13.5} = \frac{2.5}{y}$ $y = 2.5$

$A = \frac{1}{2}\, 13.5 \times 13.5 + \frac{1}{2}(2)(13.5) - \frac{1}{2}(2.5)(2.5) = 101.5$

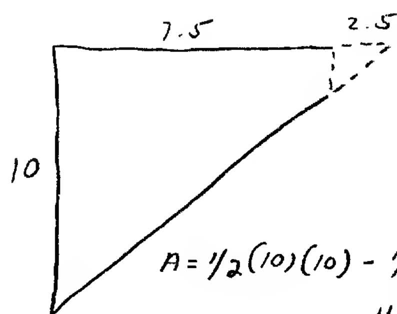


$\frac{12}{13} = \frac{y}{3}$

$y = \frac{36}{13} =$

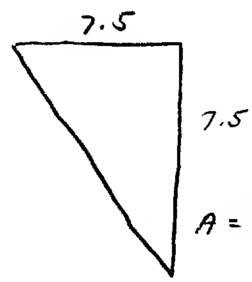
$A = \frac{1}{2}\, 13(12) - \frac{1}{2}(1)(12) - \frac{1}{2}(2.77)^2$

68.2



$A = \frac{1}{2}(10)(10) - \frac{1}{2}(2.5)^2 =$

46.9



$A = \frac{1}{2}(7.5)^2 = 28.1$

Area eliminated $= 244.7\ ft^2$

area of B102 $= 712.5 - 244.7 = 467.8\ ft^2$

$wght = \frac{\text{wght of beam}}{2} + \frac{467.8}{1305} \times (242671 - 45900)$

$= \frac{45900}{2} + 70536 = 93486^{\#}$

$wght/ft = \frac{93486}{30} \times \frac{1}{1000} = 3.12\ K/ft$

F due to 80 psf $= 80(467.8)/30 \times 1/1000 = 1.25\ K/ft$

total load $= 3.12 + 1.25 = 4.37\ K/ft$

max M = 242.4 K-ft

$$242.4 = \frac{4.37\left(30 - \frac{22}{12}\right)^2}{x}$$ $x = 14.3 \therefore$ O.K. ≈ 14 which is what is should be

$$M = \frac{WL'^2}{14}$$

$$M = \frac{4.37\left(30 - \frac{22}{12}\right)^2}{14} =$$ 247.64 which checks with an allowable of 242.4 ft-kips at midspan

if files are added at midspan this would represent an increase of .8 K/ft

$$M = \frac{(4.37 + .8)\left(30 - \frac{22}{12}\right)^2}{14} = 293 \text{ ft-kips}$$

this would represent a 21 % increase over the allowable (assuming the entire 80 psf live load has been utilized

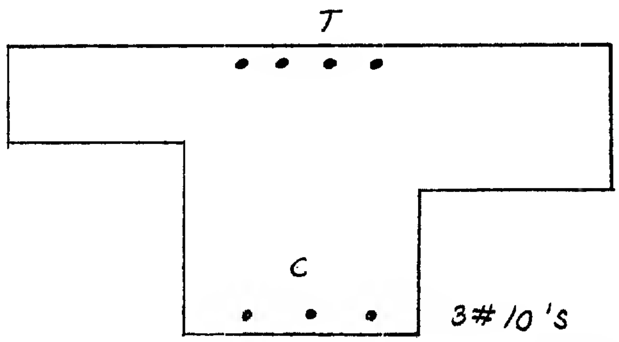
total load assuming 0 psf live load = 3.12 + .8 = 3.92 K/ft

remaining = 4.37 − 3.92 = .45 K/ft = W

allowable live load with power files = $\frac{.45 \times 30 \times 1000}{467.8}$ = 29 psf

say 30 psf

analyze beam over support



4#7's at sect A
13 # 10's at sect A
at sect B
4 # 7's
4 # 10's

3# 10's

		$3.12+1.25+.8$	$3.12+0+.8$	$3.12+1.25$
moment @ A	$= -\dfrac{wL'^2}{9}$	455.7	345.55	385.2
@ B	$= -\dfrac{wL'^2}{16}$	256.4	194.37	216.7

$$L' = 30 - 22/12 = 28.16 \quad L'^2 = 793.361$$

capacity of beam at A

$A_s = 4(.60) + 13(1.27) = 18.91\ in^2$

$A_s' = 3(1.27) = 3.81\ in^2$

assume width = 22"

$d' = 1.27 + 1.27/2 = 1.905$

$d = 20 - (1.27 + 1.27/2) = 18.1$

$$bKd\,\frac{Kd}{2} + 2nA_s'(Kd - d') = nA_s(d - Kd)$$

$$22\,\frac{Kd^2}{2} + 2(10)(3.81)(Kd - 1.905) = 10(18.91)(18.1 - Kd)$$

$$11Kd^2 + 76.2Kd - 145.16 = -189.1Kd + 3422.71$$

$$11Kd^2 + 265.3Kd - 3567.9 = 0$$

$$Kd^2 + 24.12Kd - 324.35 = 0$$

$$Kd = \frac{-24.12 \pm \sqrt{24.12^2 - 4(-324.35)}}{2} = 5.95\ in$$

$$I = \frac{bKd^3}{3} + 2nA_s'(Kd - d')^2 + nA_s(d - Kd)^2$$

$$= \frac{22(5.95)^3}{3} + 2(10)(3.81)(5.95 - 1.905)^2 + 10(18.91)(18.1 - 5.95)^2$$

$$= 1544.7 + 1246.8 + 27915.4 = 30707\ in^4$$

$$M_c = \frac{6I}{c} = \frac{1350(30707)}{5.95} \times \frac{1}{12000} = 581 \text{ ft-kips}$$

$$M_s = \frac{\frac{6}{n} I}{d - Kd} = \frac{\frac{20000}{10}(30707)}{18.1 - 5.95} \times \frac{1}{12000} = 421 \text{ ft-kips}$$

again LL must be reduced

$$\begin{array}{r} 421 \\ -\ 346 \\ \hline 75\text{K-ft for LL} \end{array}$$

$$M = \frac{wL'^2}{9} \qquad 75 \times 1000 = \frac{w(793.361)}{9}$$

$$w = 850.8\ \#/\text{ft}$$

$$6 = \frac{850.8 \times 30}{467.8} = 54.6 \text{ psf}$$

we can therefore say + moment controls
(there is no need to check section B)

The power files can be placed in the area as proposed (with some realignment) if the LL in the surrounding area is kept to 30psf. This means using tables and desks but no safes, additional files and additional partitions. All existing files should be removed.

check shear

max shear = $1.15\,w\,L'/2$

max load = $3.12 + .8 + .45 = 4.37$ K/ft

$$\text{shear} = \frac{1.15 \times 4370\ (30 - \frac{22}{12})}{2} = 70{,}776^{\#}$$

$\sigma = F/A = 70776/22 \times 18.1 = 178$ psi > 60 psi

stirrups required

shear in stirrups & bent bars = 118 psi

$118 \times 22 \times 18.1 = 46{,}987.6$

$$S = \frac{A_v f_v d}{V'} \qquad 2\#3 \text{ bars}$$

$$A_v = V'/f_v \sin\alpha \quad \leq 1.5\,b\,d\sqrt{f'_c}/f_v \sin\alpha$$

diagonal bars = 4 #10's

$$S = \frac{A_v f_v d}{V'} \qquad S = 2'' \qquad 1.5\,b\,d\sqrt{f'_c}/f_v \sin\alpha$$

$$2'' = \frac{2(.11)(20000)(18.1)}{V'} \qquad 1.5(22)(18.1)\sqrt{3000}/20000 \sin 45^\circ$$

$2.31\ in^2$

actual $= 4 \times 1.27 = 5.08$

$$fs = \frac{5.08}{2.31} = 2.2$$

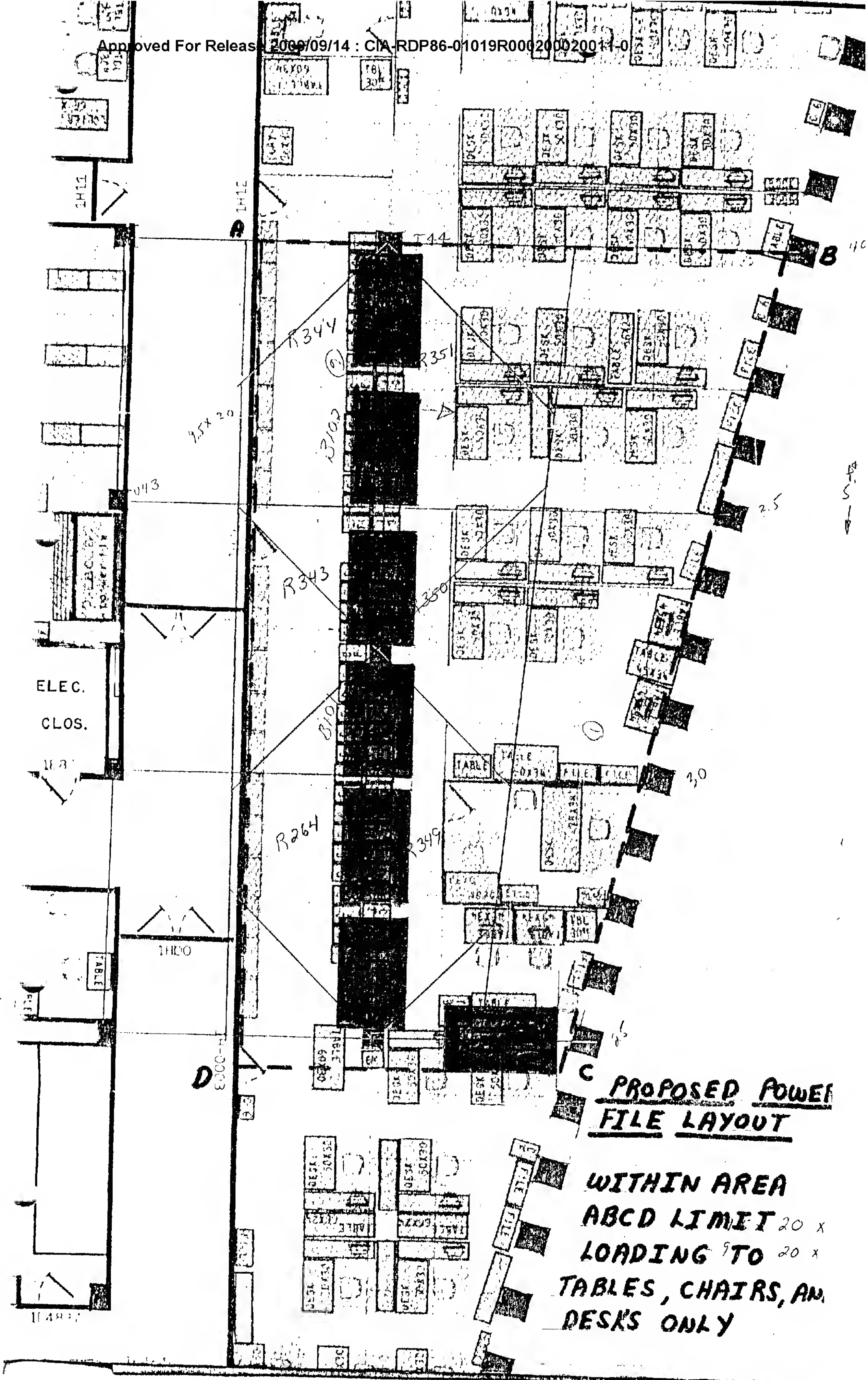
$V' = 39{,}820^{\#}$

$2.31 = V'/f_v \sin\alpha$

$2.31 = V'/20000 \sin 45^\circ$

$V' = 32668^{\#}$

$\Sigma V' = 72{,}488 > 46{,}988 \therefore$ O.K.



PROPOSED POWER FILE LAYOUT

WITHIN AREA ABCD LIMIT LOADING TO TABLES, CHAIRS, AND DESKS ONLY